

IN THE CLAIMS

1. (original) A method of processing a received signal y to produce a channel estimate comprising:

(a) decoding the received signal y to form data s ;

(b) forming a convolution matrix \hat{S} from the data s ;

(c) forming a matrix F from the data s , wherein the matrix F results from forming the matrix \hat{S} as a convolution matrix; and,

(d) performing a conjugate gradient algorithm to determine the channel estimate, wherein the conjugate gradient algorithm is based on the received signal y , the matrix \hat{S} , and the matrix F .

2. (original) The method of claim 1 wherein the performing of a conjugate gradient algorithm comprises determining a quantity q_k according to the following equation:

$$q_k = \hat{S}^T \hat{S} d_k,$$

wherein d_k is dependent upon the received signal y , the matrix \hat{S} , and the matrix F , and wherein q_k is determined by forming a first FFT of the matrix \hat{S} , by forming a second FFT of the matrix \hat{S}^T , by forming a third FFT of d_k , by multiplying the first, second, and third FFTs to produce a multiplication result, and by forming an inverse FFT of the multiplication result.

3. (original) The method of claim 1 wherein the forming of a matrix \hat{S} from the data s comprises:

forming a matrix S from the data s ; and,

forming the matrix \hat{S} from the matrix S by setting certain values of the matrix S to zero;

and wherein the forming of a matrix F from the data s comprises:

forming the matrix F from the matrix S by setting to zero the values of the matrix S not set to zero during the forming of the matrix \hat{S} .

4. (original) The method of claim 3 wherein the performing of a conjugate gradient algorithm comprises determining a quantity q_k according to the following equation:

$$q_k = \hat{S}^T \hat{S} d_k,$$

wherein d_k is dependent upon the received signal y , the matrix \hat{S} , and the matrix F , and wherein q_k is determined by forming a first FFT of the matrix \hat{S} , by forming a second FFT of the matrix \hat{S}^T , by forming a third FFT of the d_k , by multiplying the first, second, and third FFTs to produce a multiplication result, and by forming an inverse FFT of the multiplication result.

5. (currently amended) The ~~equalizer~~ method of claim 1 wherein the performing of a conjugate gradient algorithm to determine the channel estimate h comprises performing the following algorithm:

$$(1) \quad \hat{y} = y - Fh_1,$$

$$r_1 = \hat{S}^T \hat{y} - \hat{S}^T \hat{S} h_1$$

(2) For $k = 1$ to n , iteratively calculate

$$(a) \quad d_k = r_k + \beta_k d_{k-1}$$

$$(b) \quad h_{k+1} = h_k + \alpha_k d_k$$

$$(c) \quad r_{k+1} = r_k - \alpha_k q_{k-1}$$

where h_1 is an initial value of the channel estimate,

where $\beta_1 = 0$, $\beta_{k \geq 2} = \frac{r_k^T \bullet r_k}{r_{k-1}^T \bullet r_{k-1}}$, where $\alpha_k = \frac{r_k^T \bullet r_k}{d_k \bullet q_k}$, where

$q_k = S^T S d_k$.

6. (original) The method of claim 5 wherein the performing of a conjugate gradient algorithm comprises determining the quantity q_k by forming a first FFT of the matrix \hat{S} , by forming a second FFT of the matrix \hat{S}^T , by forming a third FFT of d_k , by multiplying the first, second, and third FFTs to produce a multiplication result, and by forming an inverse FFT of the multiplication result.

7. (original) The method of claim 5 wherein the forming of a matrix \hat{S} from the data s comprises:

forming a matrix S from the data s ; and,

forming the matrix \hat{S} from the matrix S by setting certain values of the matrix S to zero;

and wherein the forming of a matrix F from the data s comprises:

forming the matrix F from the matrix S by setting to zero the values of the matrix S not set to zero during forming of the matrix \hat{S} .

8. (original) The method of claim 7 wherein the performing of a conjugate gradient algorithm comprises determining the quantity q_k by forming a first FFT of the matrix \hat{S} , by forming a second FFT of the matrix \hat{S}^T , by forming a third FFT of the d_k , by multiplying the first, second, and third FFTs to produce a multiplication result, and by forming an inverse FFT of the multiplication result.

9. (original) A method of processing a received signal y comprising:

(a) decoding the received signal y to form data s ;

(b) forming a convolution matrix \hat{S} from the data s ;

(c) forming a matrix F from the data s , wherein the matrix F results from forming the matrix \hat{S} as a convolution matrix; and,

(d) performing a conjugate gradient algorithm based on the received signal y , the matrix \hat{S} , and the matrix F .

10. (original) The method of claim 9 wherein the performing of a conjugate gradient algorithm comprises determining a quantity q_k according to the following equation:

$$q_k = \hat{S}^T \hat{S} d_k,$$

wherein d_k is dependent upon the received signal y , the matrix \hat{S} , and the matrix F , and wherein q_k is determined by forming a first FFT of the matrix \hat{S} , by forming a second FFT of the matrix \hat{S}^T , by forming a third FFT of the d_k , by multiplying the first, second, and third FFTs to produce a multiplication result, and by forming an inverse FFT of the multiplication result.

11. (original) The method of claim 9 wherein the forming of a matrix \hat{S} from the data s comprises:

forming a matrix S from the data s ; and,

forming the matrix \hat{S} from the matrix S by setting certain values of the matrix S to zero;

and wherein the forming of a matrix F from the data s comprises:

forming the matrix F from the matrix S by setting to zero the values of the matrix S not set to zero during forming of the matrix \hat{S} .

12. (original) The method of claim 11 wherein the performing of a conjugate gradient algorithm comprises determining a quantity q_k according to the following equation:

$$q_k = \hat{S}^T \hat{S} d_k,$$

wherein d_k is dependent upon the received signal y , the matrix \hat{S} , and the matrix F , and wherein q_k is determined by forming a first FFT of the matrix \hat{S} , by forming a second FFT of the matrix \hat{S}^T , by forming a third FFT of the d_k , by multiplying the first, second, and third FFTs to produce a multiplication result, and by forming an inverse FFT of the multiplication result.

13. (original) A method of processing a received signal y comprising:

(a) decoding the received signal y to form data s ;

(b) forming a convolution matrix \hat{S} from the data s ;

(c) forming a matrix F from the data s , wherein the matrix F results from forming the matrix \hat{S} as a convolution matrix; and,

(d) performing a conjugate gradient algorithm based on the received signal y , the matrix \hat{S} , and the matrix F , wherein the conjugate gradient algorithm includes forming FFTs based on the received signal y , the matrix \hat{S} , and the matrix F , multiplying the FFTs to form a multiplication product, and forming an inverse FFT of the multiplication product.

14. (original) The method of claim 13 wherein the performing of a conjugate gradient algorithm comprises determining a quantity q_k according to the following equation:

$$q_k = \hat{S}^T \hat{S} d_k,$$

wherein d_k is dependent upon the received signal y , the matrix \hat{S} , and the matrix F , and wherein q_k is determined by forming a first FFT of the matrix \hat{S} , by forming a

second FFT of the matrix \hat{S}^T , by forming a third FFT of the d_k , by multiplying the first, second, and third FFTs to produce a multiplication result, and by forming an inverse FFT of the multiplication result.

15. (original) The method of claim 13 wherein the forming of a matrix \hat{S} from the data s comprises:

forming a matrix S from the data s ; and,

forming the matrix \hat{S} from the matrix S by setting certain values of the matrix S to zero;

and wherein the forming of a matrix F from the data s comprises:

forming the matrix F from the matrix S by setting to zero the values of the matrix S not set to zero during forming of the matrix \hat{S} .

16. (original) The method of claim 15 wherein the performing of a conjugate gradient algorithm comprises determining a quantity q_k according to the following equation:

$$q_k = \hat{S}^T \hat{S} d_k,$$

wherein d_k is dependent upon the received signal y , the matrix \hat{S} , and the matrix F , and wherein q_k is determined by forming a first FFT of the matrix \hat{S} , by forming a second FFT of the matrix \hat{S}^T , by forming a third FFT of the d_k , by multiplying the first, second, and third FFTs to produce a multiplication result, and by forming an inverse FFT of the multiplication result.

17. (original) A method of processing a received signal y to produce a channel estimate comprising:

(a) decoding the received signal y to form data s ;

(b) forming a convolution matrix \hat{S} from the data s ;

(c) forming a matrix F from the data s , wherein the matrix F results from forming the matrix \hat{S} as a convolution matrix; and,

(d) performing a conjugate gradient algorithm to determine the channel estimate, wherein the conjugate gradient algorithm is based on the received signal y , the matrix \hat{S} , and the matrix F , and wherein the conjugate gradient algorithm includes forming FFTs based on the received signal y , the matrix \hat{S} , and the matrix F ,

multiplying the FFTs to form a multiplication product,
and forming an inverse FFT of the multiplication product.

18. (original) The method of claim 17 wherein
the performing of a conjugate gradient algorithm
comprises determining a quantity q_k according to the
following equation:

$$q_k = \hat{S}^T \hat{S} d_k,$$

wherein d_k is dependent upon the received signal y , the
matrix \hat{S} , and the matrix F , and wherein q_k is determined
by forming a first FFT of the matrix \hat{S} , by forming a
second FFT of the matrix \hat{S}^T , by forming a third FFT of
 d_k , by multiplying the first, second, and third FFTs to
produce a multiplication result, and by forming an
inverse FFT of the multiplication result.

19. (original) The method of claim 17 wherein
the forming of a matrix \hat{S} from the data s comprises:

forming a matrix S from the data s ; and,

forming the matrix \hat{S} from the matrix S by
setting certain values of the matrix S to zero;

and wherein the forming of a matrix F from the data s comprises:

forming the matrix F from the matrix S by setting to zero the values of the matrix S not set to zero during forming of the matrix \hat{S} .

20. (original) The method of claim 19 wherein the performing of a conjugate gradient algorithm comprises determining a quantity q_k according to the following equation:

$$q_k = \hat{S}^T \hat{S} d_k,$$

wherein d_k is dependent upon the received signal y, the matrix \hat{S} , and the matrix F, and wherein q_k is determined by forming a first FFT of the matrix \hat{S} , by forming a second FFT of the matrix \hat{S}^T , by forming a third FFT of the d_k , by multiplying the first, second, and third FFTs to produce a multiplication result, and by forming an inverse FFT of the multiplication result.

21. (currently amended) The ~~equalizer~~ method of claim 17 wherein the performing of a conjugate gradient algorithm to determine the channel estimate h comprises performing the following algorithm:

$$(1) \quad \hat{y} = y - Fh_1,$$

$$r_1 = \hat{S}^T \hat{y} - \hat{S}^T \hat{S} h_1$$

(2) For $k = 1$ to n , iteratively calculate

$$(a) \quad d_k = r_k + \beta_k d_{k-1}$$

$$(b) \quad h_{k+1} = h_k + \alpha_k d_k$$

$$(c) \quad r_{k+1} = r_k - \alpha_k q_{k-1}$$

where h_1 is an initial value of the channel estimate,

where $\beta_1 = 0$, $\beta_{k \geq 2} = \frac{r_k^T \bullet r_k}{r_{k-1}^T \bullet r_{k-1}}$, where $\alpha_k = \frac{r_k^T \bullet r_k}{d_k \bullet q_k}$, where

$$q_k = S^T S d_k.$$

22. (original) The method of claim 21 wherein the performing of a conjugate gradient algorithm comprises determining the quantity q_k by forming a first FFT of the matrix \hat{S} , by forming a second FFT of the matrix \hat{S}^T , by forming a third FFT of d_k , by multiplying the first, second, and third FFTs to produce a

multiplication result, and by forming an inverse FFT of the multiplication result.

23. (original) The method of claim 21 wherein the forming of a matrix \hat{S} from the data s comprises:

forming a matrix S from the data s ; and,

forming the matrix \hat{S} from the matrix S by setting certain values of the matrix S to zero;

and wherein the forming of a matrix F from the data s comprises:

forming the matrix F from the matrix S by setting to zero the values of the matrix S not set to zero during forming of the matrix \hat{S} .

24. (original) The method of claim 23 wherein the performing of a conjugate gradient algorithm comprises determining the quantity q_k by forming a first FFT of the matrix \hat{S} , by forming a second FFT of the matrix \hat{S}^T , by forming a third FFT of the d_k , by multiplying the first, second, and third FFTs to produce a multiplication result, and by forming an inverse FFT of the multiplication result.